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1996 Feature Article - Seasonal and Trading Day Influences on Retail Turnover

INTRODUCTION

There have been substantial changes in retail trading over recent years. Some of the more notable changes are:

- Saturday afternoon and Sunday trading;
- night trading; and
- trading on public holidays.

Changing pattern of daily retail sales, especially increased retail activity on weekends, is a topical issue which has implications for the seasonal analysis of the monthly retail turnover figures published in **Retail Trade, Australia** (ABS Cat. No. 8501.0). This article explains how the ABS's seasonal adjustment procedures deal with changing "trading day" patterns, and includes a brief review of the seasonal adjustment process used. Extracting the trading day effects requires that other monthly seasonal effects be estimated and removed from the data. Results show that there have been notable changes in the trading day effect for retail turnover over time.

MAIN FEATURES OF SEASONAL REANALYSIS PROCESS

The aim of seasonal adjustment is to remove systematic calendar-related variation from the original series. For the total Australian retail turnover series, the systematic calendar-related variation in the original series is the combination of two elements, namely seasonal variation and trading day variation.

Seasonal variation is the variation in typical levels of retail activity for each month of the year, and reflects the fluctuations in the level of consumer spending for different months. Months which typically have a lower than average level of retail activity are described as seasonally low months, and those months which have a greater than average level of retail activity are called seasonally high months.

The day composition of each calendar month is the number of Mondays, Tuesdays, Wednesdays, etc. which occurs in that month. Monthly trading day variation arises from the variation in typical levels of retail activity for each day of the week, coupled with the day composition of the month.

Estimates of the seasonal variation present in time series published by the ABS are revised at least annually (usually in June) to take account of the additional twelve months' worth of data which have become available since the previous analysis. The seasonal reanalysis process usually results in some slight degree of revision to the estimates of the monthly levels of retail activity for recent years. All seasonally adjusted estimates of retail turnover in **Retail Trade, Australia** from the July 1995 issue onwards are based on the most recent seasonal reanalysis.

MAIN FINDINGS FROM LATEST REANALYSIS

The most recent estimates of **monthly** levels of total Australian retail turnover show that:

- November, and to a much greater extent December, are seasonally high months.
- January through October are seasonally low months (with March and August generally showing the lowest average level of activity).

However, in recent years there have been changes in the monthly pattern of activities, for example:

- The level of activity in December appears to be declining somewhat with a corresponding increase in January.

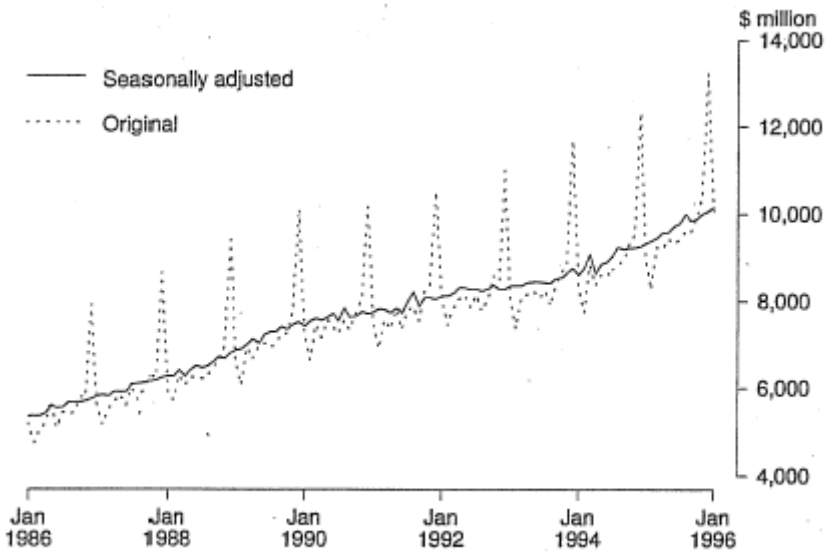
The most recent estimates of the daily levels of total Australian retail turnover for the last six years show that Wednesday is the busiest day in the week, followed in rank order by Thursday, Saturday, Friday, Monday, Tuesday and Sunday. However, changes in the trading day pattern, such as Sunday trading, have implied that retail activity is now spread more evenly across the days of the week.

The seasonal adjustment process and the results presented above are discussed in more detail below. It should be borne in mind that the results given in this article are for total Australian retail turnover, and the seasonal and trading day patterns exhibited by particular businesses or industries within retail or in particular States may differ markedly from those of the aggregate series.

WHY SEASONALLY ADJUST?

Seasonal adjustment is intended to remove the systematic calendar-related variation from an original time series. Graph 1 shows total Australian retail turnover over the last ten years in its original and seasonally adjusted forms. The most obvious feature of the original series is the large upward movement for the months of November and especially December of each year, reflecting pre-Christmas shopping. The original series also appears to show that February is the quietest month for retail trade, but the dips that occur in that month are largely due to the fact that February is the shortest month of the year. The month-to-month movements in the original series are largely driven by systematic calendar-related influences, which contribute about 80 per cent of the total variation, and the presence of such a large component swamps the other movements in the series. Often it is these other movements which may be of primary interest, and in that case the seasonally adjusted series provides a clearer picture.

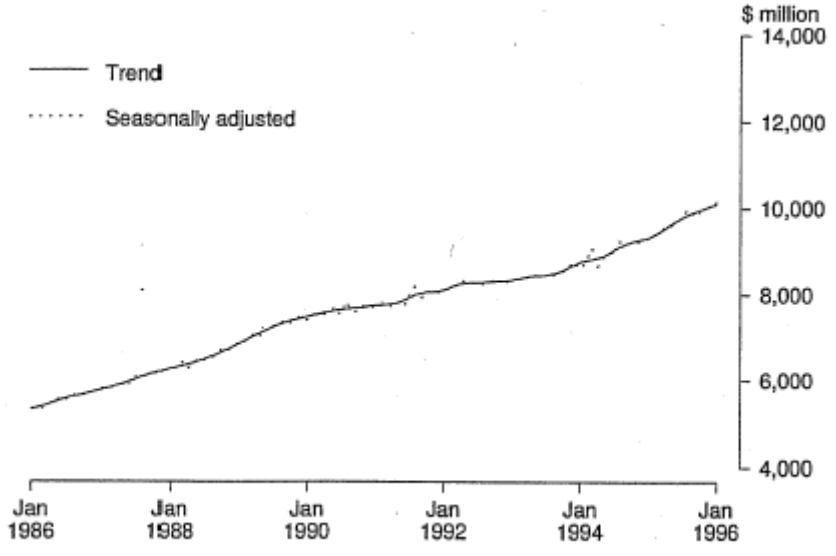
1. RETAIL TURNOVER, AUSTRALIA



Source: ABS 8501.0 Monthly data

The seasonally adjusted series shown in Graph 1 is considerably less variable than the original series, with an average absolute percentage change month-to-month of 1.06 per cent as compared to the original series which has a corresponding measure of 6.39 per cent. It should be noted, however, that the seasonal adjustment process does not remove non-systematic irregular influences from the series, so seasonally adjusted series are usually not smooth. For many economic indicators, including retail turnover, the ABS also publishes trend series from which the irregular influences have been removed. Graph 2 shows total Australian retail turnover for the past ten years in its seasonally adjusted and trend forms.

2. RETAIL TURNOVER, AUSTRALIA



Source: ABS 8501.0 Monthly data

There are instances where particular groups of users are interested in the seasonal and trading day patterns, even though for other purposes the seasonality present in the original series may be a hindrance to informed decision making. For example, businesses in the retail sector may be interested in gauging the timing and extent of seasonal variation in the level of sales activity to help them maintain appropriate stock levels or anticipate casual staff requirements. On the other hand, policy planners and macroeconomic analysts generally wish to abstract from calendar-related influences, and are likely to find the seasonally adjusted and especially the trend series

more suitable for their requirements.

The systematic calendar related effects present in total Australian retail turnover can be regarded as the combination of:

- the typical level of activity associated with each month of the year; and
- the typical level of activity associated with each day of the week.

LEVEL OF ACTIVITY FOR EACH MONTH OF THE YEAR - SEASONAL VARIATION

The pattern of retail activity across the months of the year reflects several influences.

One influence is the differing number of days in the twelve months of the year. If no other calendar related effects were present, then the amount of retail turnover recorded for the month of February (which has 28 days in a non-leap year and 29 in a leap year) would be less than for the other months. The amount of retail turnover recorded for April, June, September and November (which have 30 days) would in turn be less than for the remaining months (which have 31 days).
It is straightforward to remove the effect of the differing number of days in the various months from the data. Since normal years are 365 days in length and leap years 366 days long, an "average" month is 365.25/12 = 30.4375 days in length. By comparing the actual number of days in a given month to the average number of days per month, an adjustment factor can be readily calculated. In practice, it is convenient during the X11 computations to include this length-of-month adjustment with the trading day adjustment discussed below.

A second influence on the pattern of retail activity across the months is the occurrence of Christmas, other special days (such as Valentine's Day, Mother's Day and Father's Day), public holidays (such as Australia Day and Easter), and mark-down sales (such as post-Christmas, stocktake and end-of-financial-year sales). The issue about Mother's and Father's Days is that they fall on the first Sunday of the month. If the first Sunday happens to fall on the first few days of the month, it is likely that some, if not most, of the gift purchases would have spilled over to the previous month. Similarly, with the shifting of Easter, pre-Easter purchases are likely to fall in March if Easter is in early April.

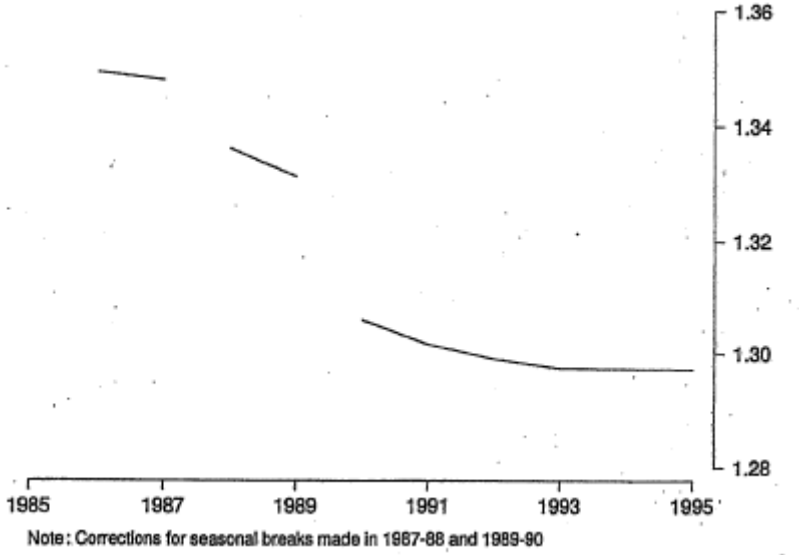
A third influence is the run of seasons which affects spending on such things as winter and summer clothing, heating and cooling appliances and seasonal recreational equipment.

To estimate the seasonal variation in retail activity, X11 calculates a series which contains seasonal and residual/irregular variation, but which has had preliminary estimates of other influences such as trend removed. The seasonal-irregular values are grouped by month so that all the January observations are arranged in a yearly sequence, all the February observations are arranged in a second sequence, and so on for the other months. Each sequence is then smoothed (using a "seasonal moving average") to obtain an estimate of the typical level of retail activity for that month over time. This is a simplified description of the actual process involved; a more rigorous treatment is given in the **United States Bureau of the Census Technical Paper 15**.

An important feature of the X11 procedure is that it allows the seasonal pattern to be estimated even though that pattern is usually not fixed but is evolving year by year. For example, it appears that consumers have modified their behaviour by postponing some of their pre-Christmas spending (to take advantage perhaps of the January mark-down sales), and as a result there has been a decrease in the level of activity for December and an increase in the level of activity for January over the past few years (see Graphs 3 and 4). Provided that the seasonal pattern evolves in a slow and continuous fashion, the seasonal moving averages generally work well in

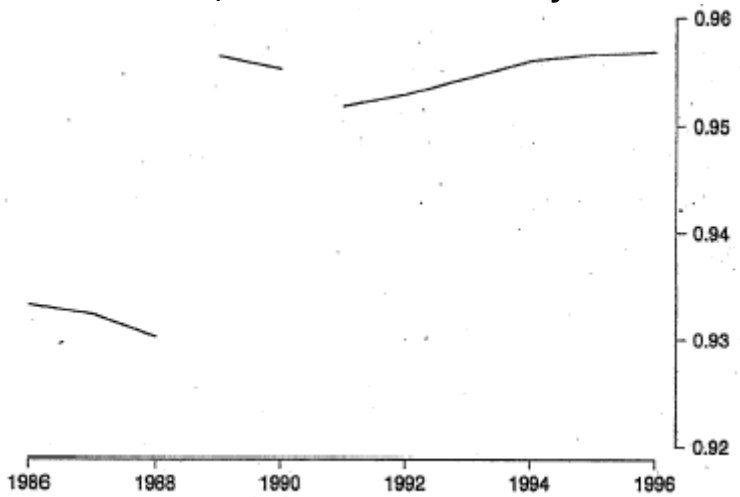
reflecting the changing seasonality. Occasionally the seasonality may change in a rapid or abrupt manner, and the estimates produced by the seasonal moving averages may fail to capture adequately the changing seasonal pattern. If necessary, ABS time series analysts apply an adjustment (called a “seasonal break correction factor”) to ensure that the estimates of seasonal variation properly capture the series behaviour. At each seasonal reanalysis the performance of the X11 procedure is carefully monitored and assessed to ensure that the estimates of seasonal variation used in producing seasonally adjusted series are appropriate.

3. RETAIL TURNOVER, AUSTRALIA - December Seasonal Factors



Note: Corrections for seasonal breaks made in 1987-88 and 1989-90

4. RETAIL TURNOVER, AUSTRALIA - January Seasonal Factors



Note: Corrections for seasonal breaks made in 1988-89 and 1990-91.

The **most recent estimates of monthly levels of total Australian retail turnover** show that November, and to a much greater extent December, are seasonally high months. However, as mentioned above, the activity level in December appears to be declining somewhat over more recent years, with a corresponding increase in January. January through October are generally seasonally low months but the level of activity varies from month to month:

- March and August display the lowest level of activity. The level of activity in August has also fallen in recent years.
- The level of activity in April, May and June are higher than that of the preceding three months. The level of activity in April has increased in recent years.
- The level of activity in July is lower than in June but higher than in August,

- September and October are only a little below seasonally neutral (the average level of activity), although the level of activity in October has steadily increased over time.

LEVEL OF ACTIVITY FOR EACH DAY OF THE WEEK - TRADING DAY VARIATION

Monthly trading day variation refers to the variation in the level of activity which is related to the number of times each of the days of the week occurs in the calendar month. Some days of the week are busier for retail turnover than others. One of the reasons for this may be the pattern of pay days, Social Security payments etc. The composition of any particular month (in terms of the number of Mondays, Tuesdays, etc.) will affect the amount of retail turnover recorded for that month. The day composition of each calendar month varies from one year to the next. There are 22 different types of months:

- There are seven types of 31-day months. 31-day months beginning on Monday contain five Mondays, Tuesdays and Wednesdays and four of the other days of the week. 31-day months beginning on Tuesday contain five Tuesdays, Wednesdays and Thursdays and four of the other days of the week; and so on for months beginning on the other days.

- There are seven types of 30-day months. 30-day months beginning on Monday contain five Mondays and Tuesdays and four of the other days of the week; and so on for months beginning on other days.
- There are eight types of Februarys. There is one type of non-leap-year February, containing exactly four weeks and hence four occurrences of each day of the week. There are seven types of leap-year Februarys: one beginning on Monday; one beginning on Tuesday; and so on.

The day composition of any particular month can be ascertained by referring to a calendar, but the level of activity occurring on each day of the week is usually unknown, and must be estimated in order to apply a trading day adjustment. Unfortunately, estimating trading day variation is more problematic than estimating the trend or seasonal variation of a time series. The required information could in theory be obtained by asking respondents to provide figures on their daily turnover, but this would entail a massive increase in respondent load and would be tantamount to conducting a daily, rather than a monthly, survey. Many survey respondents could, if asked, provide anecdotal evidence about which days of the week are busy and which are quiet for their particular businesses, but qualitative descriptions such as “Saturdays are our busiest days but Wednesdays are slow” are not very useful, since what are required are numerical measures. Even when available, anecdotal evidence may not be in agreement with the actual pattern observed in the data, which may be influenced by bookkeeping, reporting or data processing practices. Due to the cost and difficulty involved, the activity levels occurring on the different days of the week are not obtained from external evidence but instead are estimated from the monthly time series itself. The resulting measures of activity level for each of the days of the week are known as the “daily weights”.

ESTIMATING DAILY WEIGHTS

In contrast to the task of estimating the annual pattern of level of activity associated with each month of the year (where a yearly pattern is being extracted from monthly data), estimating the daily weights requires a weekly pattern to be extracted from monthly data. In the first instance, a lower frequency pattern is being estimated from higher frequency data, and moving averages can be used. In the second instance, however, a higher frequency pattern is being estimated from lower frequency data and some model must be imposed on the relationship between pattern and data. The X11 procedure uses a multiple regression model to estimate daily weights; this

imposes a couple of constraints on the time series analyst, which in turn have consequences for users of the retail statistics:

- First, fitting a regression model demands a reasonable amount of data if the results are to be accurate enough to be useful for adjusting series. X11 needs at least five years of data (60 monthly observations) for its trading day algorithm to become operative.
- Second, the daily weight estimates given by the regression model are fixed numerical values. The standard procedure is to apply the regression model to the whole span of the time series, so the daily weights are assumed not to change from year to year.

This second constraint is unrealistic for a series such as total Australian retail turnover, as there is a good deal of evidence that there have been substantial changes in the proportions of activity occurring on particular days of the week during the past three decades. Series for which the proportion of total activity occurring on particular days of the week changes through time are said to exhibit a “moving trading day” effect.

CAUSES OF MOVING TRADING DAY EFFECT

Retail trade estimates published in **Retail Trade, Australia** are given for the eight States and Territories and by seven industry groups, each of which contains several subgroups as set out in the explanatory notes of that publication. Estimates of retail turnover at the total Australia level have been published since 1965, while retail industry estimates at the State and Australian levels have been included in the survey starting in 1982. The Northern Territory (by broad industry) was added in 1988. The total Australia series is seasonally adjusted separately from the State and industry series as data are available over a much longer time span. Conceptually, however, the total Australia retail turnover series can be regarded as the sum of a large number of component series, each of which has its own trading day pattern. The moving trading day effect present in total Australian retail turnover arises from changes in the trading day patterns of component series and also from changes in the relative contribution of those components to the total. Some changes in the trading day patterns of component series are sudden, while others are relatively gradual.

Changes in the trading day patterns for component series

Among the rapid changes that have affected the turnover series for some States are amendments to legislation about trading hours; in particular, the restrictions on Sunday trading have been relaxed and the level of retail activity on Sunday has increased. Changes of a more gradual nature include the tendency in more recent years of some retailers (such as major supermarket chains) to keep their stores open for extended hours or around the clock. Customers have altered their shopping habits in response.

Changes in the contributions by component series.

Examples of businesses that have made an increasing contribution to retail turnover over more recent years (and whose particular trading day patterns have a greater impact on the total Australia series than previously) are supermarket and grocery stores and cafes and restaurants. Clothing retailers and hotels and licensed clubs are among the businesses whose relative contribution has decreased.

Tuning the trading day adjustments

In applying the X11 seasonal adjustment procedure (in particular, when using a multiple

regression model to estimate daily weights), the ABS has sought to strike a compromise between two conflicting aims of trading day estimation:

- The first aim is to make the adjustment as relevant as possible to the pattern in a given period, especially at the current end of the series which is of greatest interest to users. When the trading day influences are evolving, this suggests using as short a span of data as possible to estimate the daily weights.

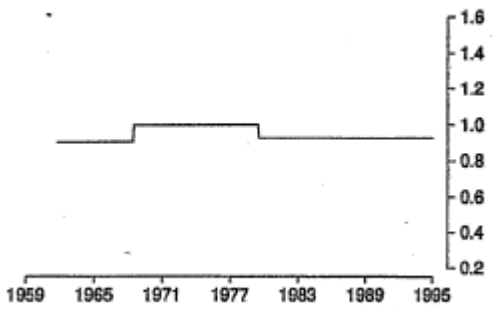
- The second aim is to make the estimates of daily weights (and hence of the trading day adjustment) as statistically accurate as possible. This suggests using as long a span of data as possible when estimating the daily weights.

To make allowance for the moving trading day effect evident in total Australian retail turnover while still providing enough data to the regression model, the series is broken up into a number of contiguous segments or sub-spans, each of which has its trading day pattern estimated separately. Bearing in mind that at least five years' worth of data must be included in each sub-span, it is not possible to fit a large number of very short sub-spans. Fairly long sub-spans are used to ensure that the daily weights obtained are of acceptable accuracy, while the fact that the weights for each day are free to change between sub-spans allows the daily weights to adapt to changes in the trading day pattern over time.

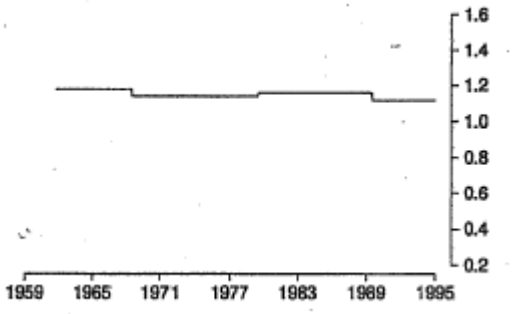
While the use of data sub-spans for trading day estimation undoubtedly represents an advance on estimating a fixed set of daily weights over the entire series, a sudden change in the trading day pattern cannot be successfully estimated until sufficient data containing the new pattern become available. If such a change starts to develop it is usually necessary to wait for at least two to three years of data with the new pattern to be collected and tabulated, and even then the daily weights estimated from the last sub-span may not be an especially good fit to either old or new pattern but rather a compromise between the two. In this situation the cut-off date between the last two sub-spans, and the daily weights for each sub-span, may need to be periodically revised as more data become available for analysis. This can lead to revisions in the last several years of seasonally adjusted estimates. The impact on trend estimates of revisions to the daily weights is usually minor.

5. TRADING DAY WEIGHTS

5.1 Monday

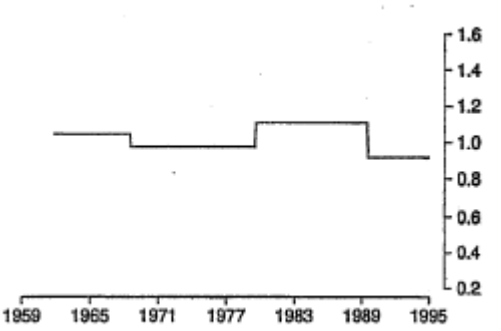


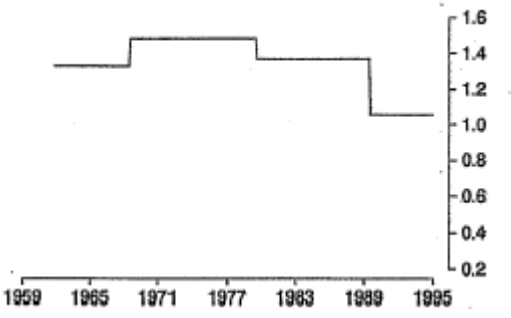
5.4 Thursday



5.2 Tuesday

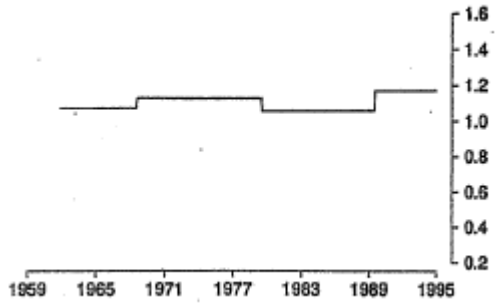
5.5 Friday

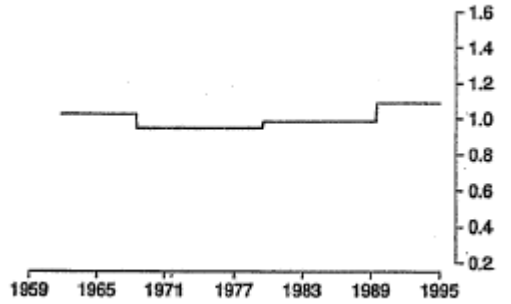




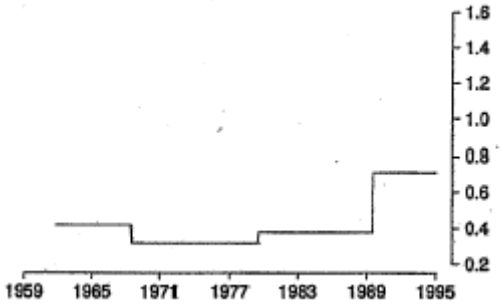
5.3 Wednesday

5.6 Saturday



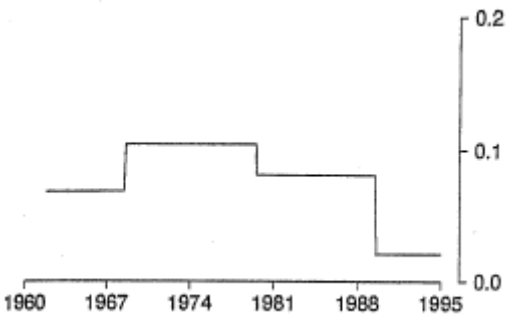


5.7 Sunday



At the present time the sub-spans used for trading day estimation of total Australia retail turnover cover the periods April 1962 to December 1968, January 1969 to December 1979, January 1980 to December 1989, and January 1990 to the end of the series. The daily weights are constructed so that they must sum to seven, which implies that the average level of activity must equal one. A low (high) activity day is one which has trading day weights below (above) 1. An examination of the daily weight changes between the four sub-spans reveals that Monday is a consistently low activity day over the whole series, while Tuesday is more variable, being sometimes above average and sometimes below. Wednesday and Thursday are consistently high activity days while Friday is also a high activity day but has become considerably less so over the most recent time period. The level of activity for Saturday is about average and Sunday is a low activity day but showing a noticeably increased level of activity for the latest period. (See Graph 5) However, changes in the trading day pattern, such as Sunday trading, have implied that retail activity is now spread more evenly across the days of the week. The average deviation of each day's level of activity from the neutral or average level has lessened(see Graph 6). This implies that the influence that the trading day pattern has on retail turnover estimates has lessened in recent years.

6. TRADING DAY WEIGHTS - Overall Mean-Squared Difference From 1



As the patterns of trading day activity present in total Australian retail turnover evolve, the ABS will continue to monitor the daily weight estimation process in the light of new data as it becomes available and will make changes as required.

The ABS is conducting an ongoing program of research with the aim of developing improved procedures for estimating trading day variation when moving trading day effect is present. One technique which is currently being investigated uses a “sliding” sub-span or moving data window to estimate daily weights which are able to vary over the length of the series, rather than being fixed within sub-spans. The raw regression estimates obtained in this way are unacceptably volatile and are smoothed using moving averages to give better results. For most of the length of the series a sliding sub-span centered on the point of time at which the daily weights are being estimated is used, but at the ends of the series a centered sub-span cannot be used as there is insufficient data and the method must be modified. The technique is still experimental, and is used by ABS time series analysts mainly as an investigatory tool and to corroborate the fixed sub-span estimates. After further refinement and development, the sliding-span procedure may prove to be a viable alternative to the fixed sub-span method of producing trading day adjustments for officially released statistics.

CONCLUSION

The seasonal adjustment of total Australian retail turnover involves the decomposition of the original series into a trend series, systematic calendar related effects, and residual/irregular variation. The second of these represents the combined effect of the level of activity for each month of the year, and trading day variation resulting from the different amount of retail turnover associated with each day of the week. Estimates of the seasonal variation present in time series published by the ABS are revised annually, and in the light of evidence suggesting possible changes in retail trading patterns, including increased retail activity on weekends, the adjustment for trading day influences was substantially revised at the last seasonal reanalysis.

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